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**Technical Evaluation of the UH-60Q:
Medical Suction System**

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By

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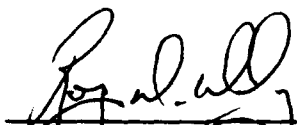
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<p>The UH-60Q prototype MEDEVAC Black Hawk is configured to provide day/night, adverse weather, emergency movement of patients. The objective of this report is to describe the results of performance test on the medical suction system installed on the prototype aircraft.</p> <p>The medical suction system in the aircraft consists of two independent suction pumps capable of producing from 0 to 250 mmHg continuous or intermittent vacuum through any of six 1/4-inch ports. Each port accommodated an air flow of 17 to 18 liters per minute and was not affected by operation of other ports on the same pump.</p> <p>The redundant design of the system will provide some backup capability if a single suction pump fails. Labeling of the controls requires modification. Medical aidmen operating the unit recommended the pressure controls and outlets be moved to the control panel by the head of the patient.</p>					
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Introduction

The UH-60Q prototype MEDEVAC Black Hawk is configured to provide day/night, adverse weather, emergency movement of patients. The Materiel Need Statement for the UH-60Q directs that the aircraft be capable of performing medical evacuation in several mission profiles (Department of the Army, 1992). These include Southwest Asia, Europe, MAST, and Persian Gulf scenarios that are summarized in Appendix A. The U.S. Army Aeromedical Research Laboratory (USAARL) was tasked by the Utility Helicopter Program Manager to evaluate the UH-60Q aircraft in flights that simulate the typical mission profiles. This information is needed to determine functional requirements for future operational and user tests of the UH-60Q. This report details the results of technical evaluations of the medical suction system of the aircraft. An analysis of other features of the medical interior and details on the performance of the aircraft system in mission scenarios is detailed in other reports.

The UH-60 aircraft, serial number 86-24560, is configured as the Proof of Principle Aircraft YUH-60A(Q). This helicopter is equipped with an enhanced medical interior, enhanced avionics and visual displays, and an externally-mounted rescue hoist.

The objective of this report is to describe the results of performance tests on the medical suction system. This information will be useful to the Utility Helicopter Project Manager when evaluating how each component of the medical interior enhances or degrades the ability of a typical flight medic to perform his duties.

Materials and methods

The medical suction system is a pair of electrically powered suction pumps which provide suction at a regulated pressure to six outlets in the aircraft. The suction system is manufactured by Air Methods, Inc., Denver. Each suction pump operates independently and is mounted in the area between the aircraft fuselage and the litter lift system. Three suction outlets are located at the top of each litter lift. The on/off power control for the pump and three outlets is mounted on the bulkhead for the corresponding lift. The pressure control for each outlet is mounted below the corresponding outlet. The system is capable of producing continuous suction from 0 to 240 mmHg through a 1/4-inch hose outlet. The units also produce intermittent suction with an adjustable duration for suction and rest periods. The suction outlets and pressure controls are shown in Figure 1. Figure 2 shows the power switch for a suction system on the bulkhead at the front edge of the cargo door.

There were no formal procedures, manuals, or training program available for operating the suction system. Operation of the suction system was determined by observation of the unit functions and hands-on practice.

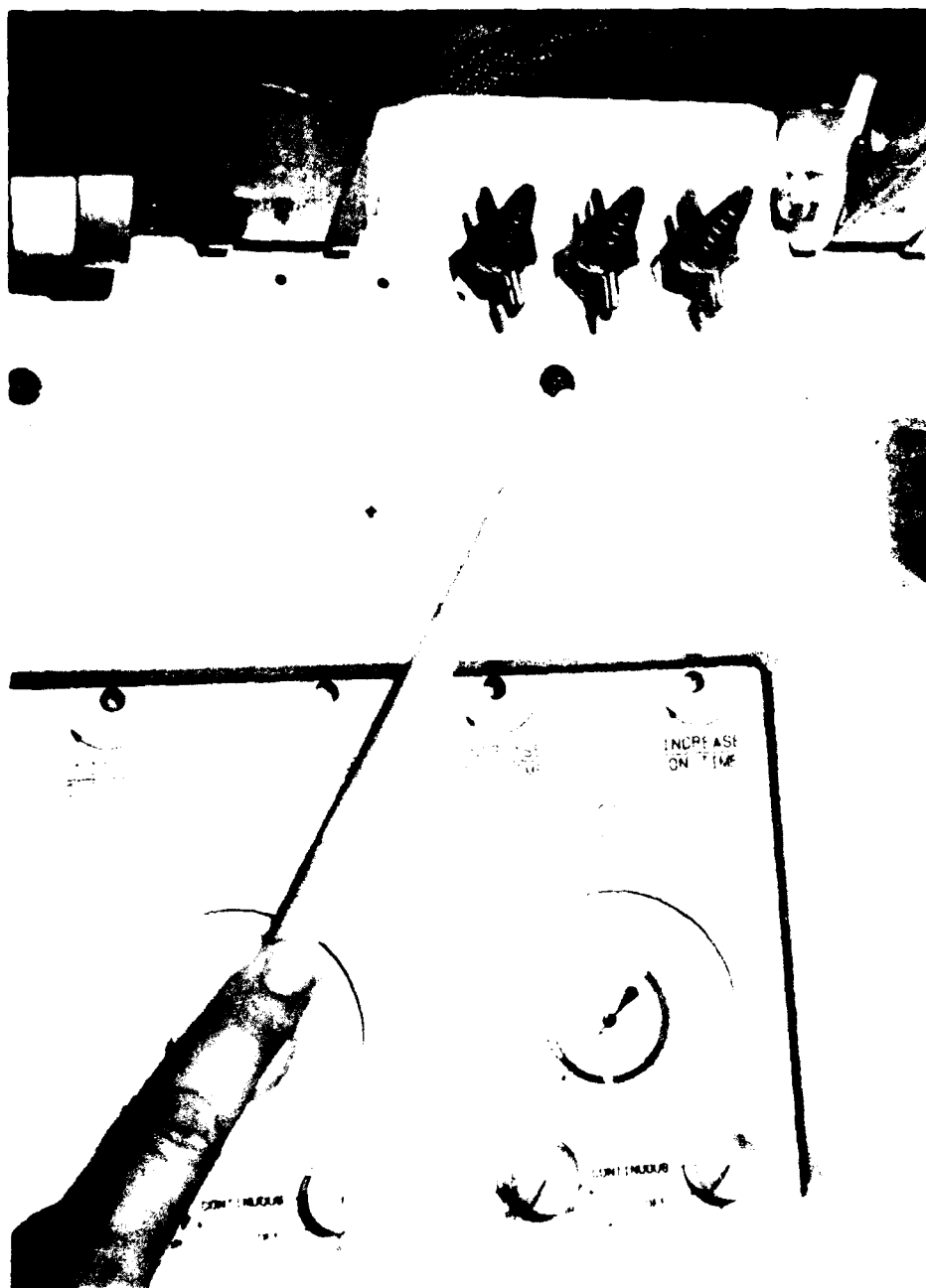


Figure 1. Suction outlets and pressure controls located at top of the litter lift system.

The pressure (vacuum) produced by each outlet was checked with a pressure gauge through the range of operating pressures during ground operation. Each outlet was evaluated when operated alone and when another outlet on the same pump was producing maximum

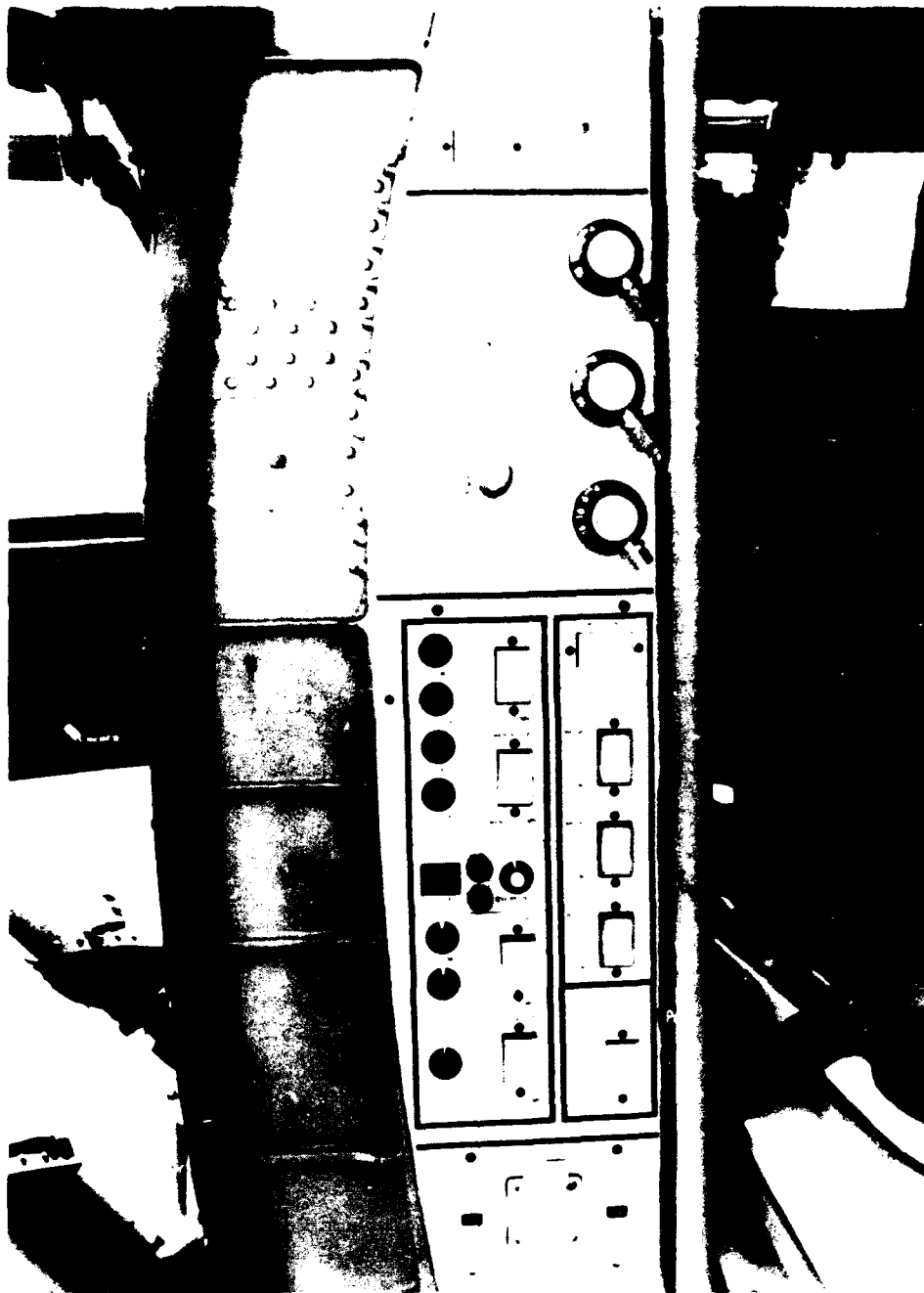


Figure 2. Control panel for lift mechanism, patient lighting, and oxygen outlets.

flow. Provisions of the airworthiness release for the aircraft prevented in-flight evaluation of the performance of the suction system

Results

The medical suction system is capable of producing an adjustable regulated pressure (vacuum). Each suction outlet produced a maximum flow of 17 to 18 liters per minute and the individual outlet controls were calibrated accurately. A comparison of the indicated and measured pressure for each outlet is shown in table 1. The regulated pressure did not change when another outlet using the same suction pump was operating at maximum flow.

Table 1.
Comparison of selected and measured pressure (mmHg) for each suction outlet.

	Measured pressure - left side outlets			Measured pressure - right side outlets		
Selected pressure	A	B	C	A	B	C
Max flow	261	245	267	251	257	250
150	148	147	150	159	160	156
100	101	98	102	109	113	108
50	57	53	56	57	66	59

Discussion

The suction systems in the prototype aircraft are capable of producing a regulated suction during ground operation as designed. In-flight evaluation is required to confirm similar operation in the lower pressure atmosphere at higher altitudes. The presence of redundant systems in the aircraft reduces the potential for loss of suction due to mechanical failure of a single unit. It was possible to use the suction system on one litter lift to perform suction on a patient on the opposite lift.

There is no specific operational capability for a medical suction system detailed in the Materiel Need (MN) document for the UH-60Q (Department of the Army, 1992). A letter of inquiry on suction apparatus performance from the Director of Combat Developments, former Academy of Health Sciences (1991) details the minimum acceptable performance of a suction system include a suction range of 0 to 250 mmHg, flow not less than 2 liters per minute, capable of continuous and intermittent operation, vacuum level selection control, and will interface with disposable or reusable collection containers. The suction system in the UH-60Q exceeds these minimum requirements.

The suction outlets should be labeled to correspond to the vacuum gauge letters (Figure 1). The intermittent label on the operation selector for each suction outlet is covered by the face plate on the litter lift. This control is marked for continuous, off, or intermittent operation as shown in Figure 3. Medical aidmen simulating use of the suction system in typical evacuation missions stated a preference that all outlets and controls for the suction system should be mounted on the control panel with the power switch. This will facilitate operation from their seat and provide best access to suction the upper airway.

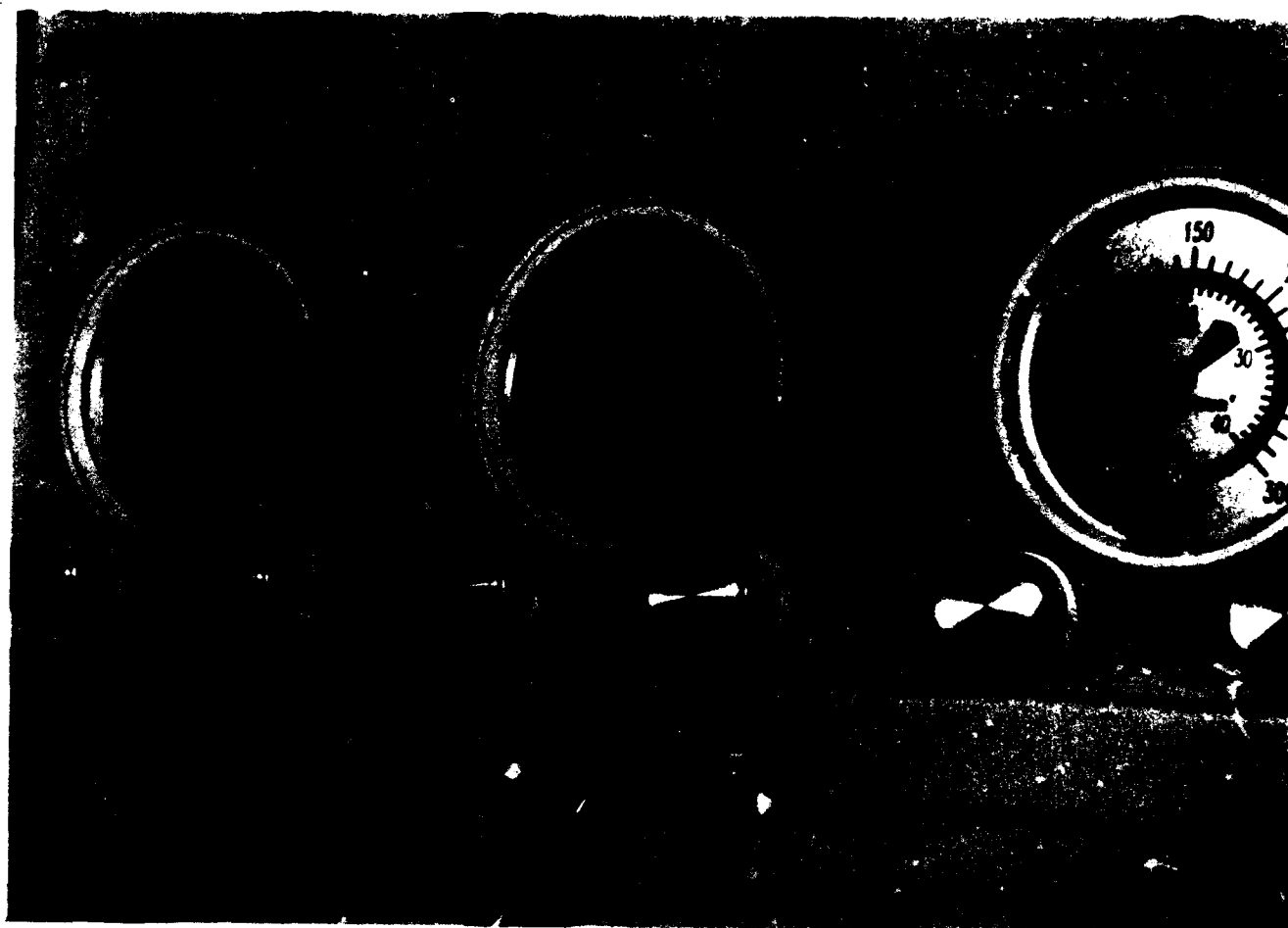


Figure 3. Label of pressure regulators is partially obscured.

Summary

The medical suction system in the prototype aircraft consists of two independent units installed between the litter lift system and the aircraft fuselage. This arrangement provides redundancy in the event of a mechanical failure of one system. Each of the two suction units is capable of providing continuous and intermittent regulated suction from 0 to 250 mmHg vacuum through three 1/4-inch outlets. The maximum flow through any single outlet is between 17 and 18 liters per minute.

Improvements in labeling of the suction outlets and control are required. Medical aidmen stated a preference that the suction outlets and all controls should be mounted on the control panel with the power switch.

References

Department of the Army. 1992. Appendix 1, UH-60A Black Hawk materiel need, production, dated 1979, (MN) (P) for Dustoff Black Hawk (UH-60Q).

Moody, H. L. 1991. Letter of inquiry, suction apparatus. Fort Sam Houston, TX: Memorandum for Commander, U.S. Army Medical Research and Development Command, ATTN: SGRD-ZX. April 1.

Appendix A.
Mission profile summaries

A. AEROMEDICAL EVACUATION (SOUTHWEST ASIA). The UH-60Q, collocated with a forward support medical company in direct support to a maneuver brigade, receives a mission to transport a trauma treatment team from the forward support medical company forward to a battalion aid station and then evacuate six litter patients and one ambulatory patient from the battalion aid station to the division clearing station located in the brigade support area (BSA). The UH-60Q departs the BSA with the trauma treatment team and flies at an airspeed of 120 knots using contour flight technique for 67 nautical miles (nm) and then slows to an airspeed of 30 knots using NOE flight technique for the last 3 nm to the battalion aid station. The trauma treatment team is off-loaded and the patients are loaded into the aircraft. (20 minutes allocated for loading and unloading) The UH-60Q departs the battalion aid station using NOE for the first 3 nm and then transitions to contour flight for the remaining 67 nm to the BSA. The patients are off-loaded at division clearing station (10 minutes allocated) at which time the aircraft is ready for the next mission. Total time for the mission, to include patient loading and unloading times, is approximately 118 minutes.

Event	Distance (nm)	Speed (kts)	Flight mode	Time (min)
1 - 2	70	120/30	LL/NOE	44
Load patients			Landed	20
2-3	70	30/120	NOE/LL	44
Unload patients			Landed	10
TOTAL	140			118 (1.9 hr)

B. AEROMEDICAL EVACUATION (MAST). A UH-60Q located at a military installation receives a night MAST mission to transfer two patients involved in a traffic accident from a small community hospital to a medical center capable of providing life saving (definitive) medical treatment. The gaining hospital requests the mission and provides two nurses and a critical care physician to assist in the enroute care of the patients. The weather is marginal but acceptable. The small community does not have an airport or weather reporting capability and is not situated along the FAA enroute and terminal flight system. After premission planning, the crew flies to the medical center (8 nm, 125 kts, low level) to pick up additional health care providers (5 minutes for loading). The crew uses onboard navigational equipment to locate and fly to the community hospital (80 nm, 120 to 145 kts, contour or low level). Unforecast weather was encountered at the pickup site. After landing, the health care team goes into the hospital to obtain patient briefings and execute transfer of patient responsibility (10 minutes for loading). The physician and the medic attend the adult patient while the nurses attend the baby. Once

loaded, the crew departs for the medical center. The patients require constant enroute treatment and monitoring on the return flight. The health care providers must use white light to provide appropriate care and must talk back and forth constantly. The female patient's condition deteriorates requiring the physician to contact the medical center to alert the operating room personnel of the requirement for immediate surgery upon arrival. Upon landing at the hospital helipad, the patients are off loaded and moved into the hospital. The flight crew returns to the military installation (8 nm) and mission is complete. Total mission time is 2 hours.

Event	Distance (nm)	Speed (kts)	Flight mode	Time (min)
1 - 2	8	125	LL	5
Load personnel			Landed	5
2-3	80	120-145	LL	40
Load patients			Landed	10
3-4	80	145	LL	35
Offload patients			Landed	10
4-5	8	125	LL	5
TOTAL	176			120 (2 hr)

C. AEROMEDICAL EVACUATION (PERSIAN GULF). Low level flight for a distance of 200 nm with an airspeed of 110 to 120 kts. Hoist rescue from a hover of less than 70 feet (25 minutes allowed) followed by 170 nm low level flight at 110 to 120 nm. At this point, the patients are offloaded and the aircraft flies 50 nm (low level) at an airspeed of 110 to 120 kts.

Event	Distance (nm)	Speed (kts)	Flight mode	Time (min)
1 - 2	200	110-120	LL	120
Rescue			Hover	25
2-3	170	110-120	LL	105
Unload patients			Landed	
3-4	50	110-120	LL	25
Offload patients			Landed	10
TOTAL	420+			275-305 (5.1 hr)

Adapted from Annex B, Appendix 1, UH-60A Black Hawk Materiel Need, Production, dated 1979 (MN) (P)

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